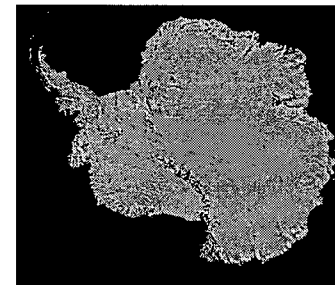


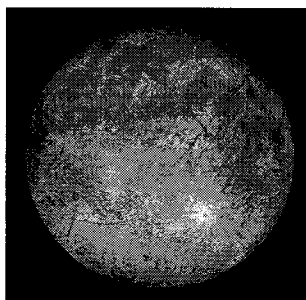


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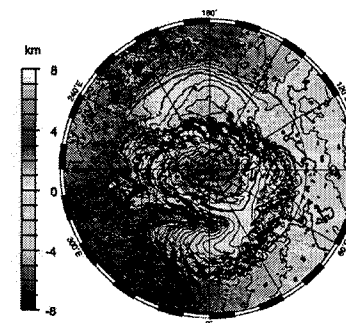


THE JPL CRYOLAB SUPPORT FOR DEEP SUBGLACIAL IN-SITU SCIENCE AND TECHNOLOGY PROGRAMS

FRANK CARSEY and LLOYD FRENCH
JET PROPULSION LABORATORY

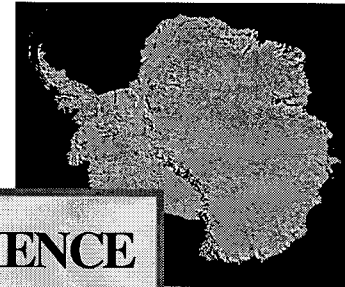


F Carsey, 2001





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EARTH AND PLANETARY DEEP SUBGLACIAL SCIENCE

Earth:

Ice Dynamics: Basal Processes, Changes in Frozen-Wet Boundary, Fabric
Paleoclimatology (Glaciochemistry): Composition, Dust Concentration
Subglacial Lakes: Water Chemistry, Dynamics

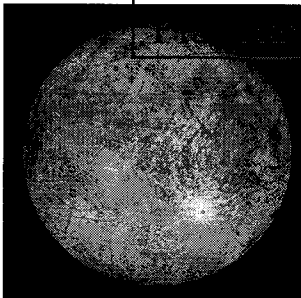
Mars:

Climate History: Chemical Horizons, Dust Mineralogy, Sedimentology,
Isotopic Geochronology
Biology: Organics, Chemical Strata, Sediment Mineralogy

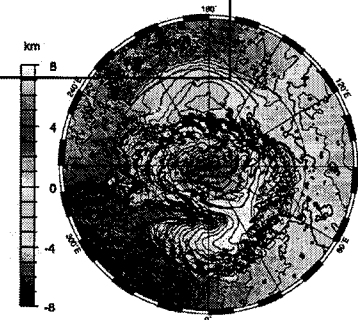
Europa:

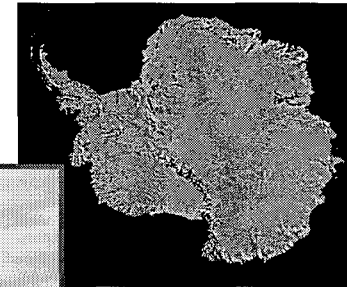
Biology: Biochemical Inclusions, Organic Abundance, Particulate
Makeup, Chemical Strata, Ice Biota

History: Profiles of Inorganics, Sediment Character



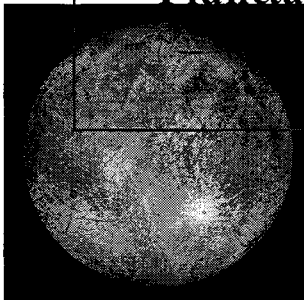
F Carsey, 2001



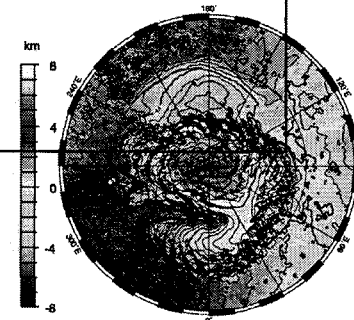


TECHNOLOGIES FOR PLANETARY SUBGLACIAL SCIENCE

- **Scientific In-Situ Sample Acquisition Process**
 - Where on planet/Where at site/What sample/What in sample?
- **Access to Subsurface**
 - Mobility to multi-kilometer depths
- **“Documentation” In the Subglacial**
 - Regional Scale: radar or sonar mapping
 - Local Scale: Photography, sonar, radar
 - Microscale: Microscopy, Electron or Visible Light
- **Scientific Observation**
 - Micro-instrumentation: Mass-Spec, Raman/Fluor. Spec., etc
- **Planetary Protection: An Issue of Increasing Significance**
 - Planning, Verification



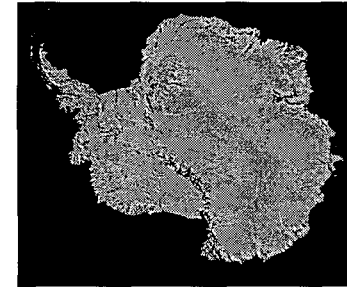
F Carsey, 2001





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SPECIFYING THE JPL CRYOBOT DEVELOPMENT



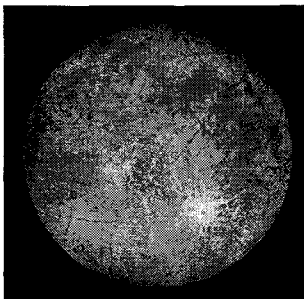
CRYOBOT:

- **OBJECTIVES**

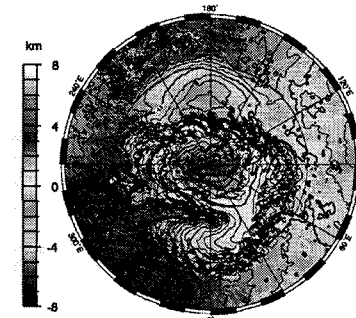
- In-Situ Science in Surrounding Ice, Meltwater
- Chemistry; Gas Analysis; Particulate Study; Inclusions
- Detection of Biomarkers

- **REQUIREMENTS (LONG-TERM)**

- Space-Capable (Mass/Volume/Power/Data Rate/Autonomy)
- Range to 30 km
- Non-Contaminating
- Tolerate Environmental Uncertainty
- Accommodate Science Instrumentation TBD



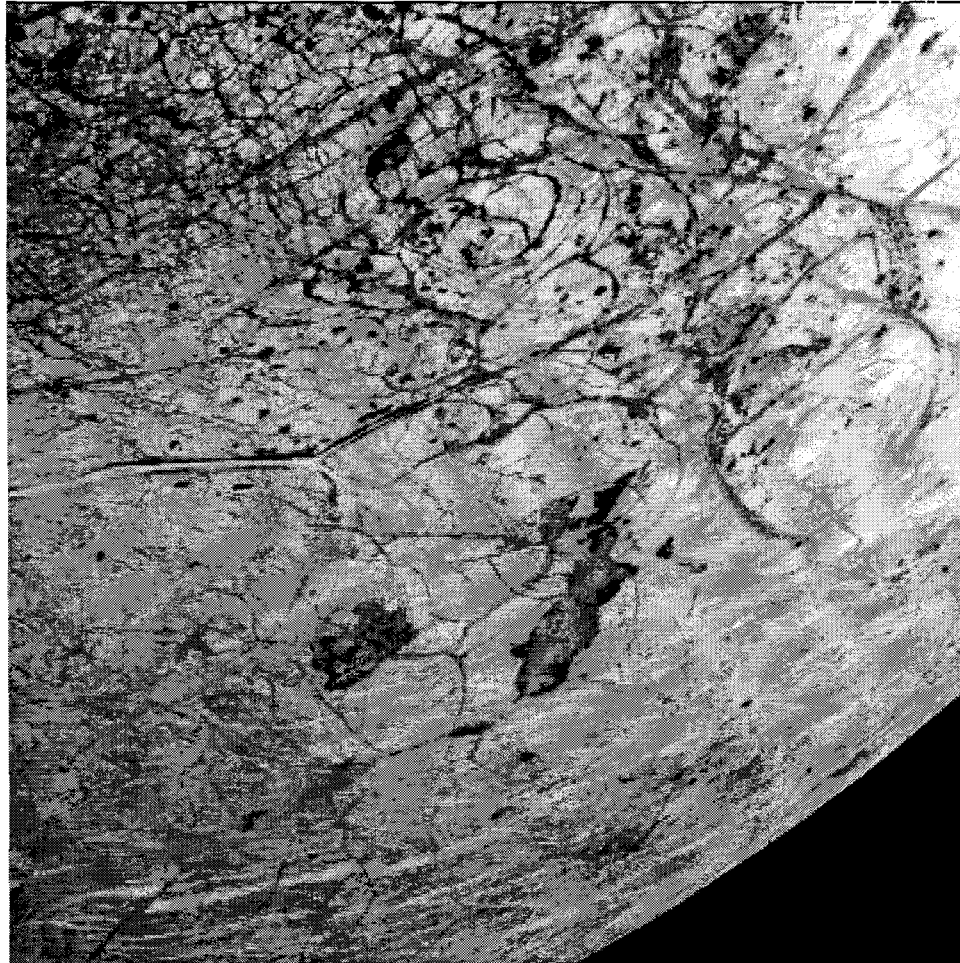
F Carsey, 2001



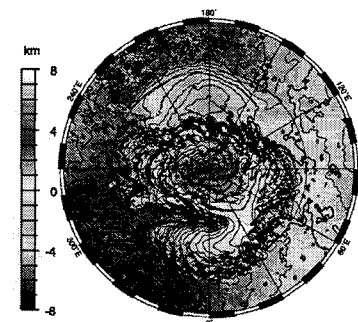
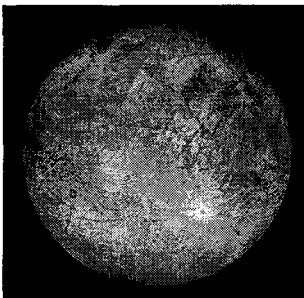
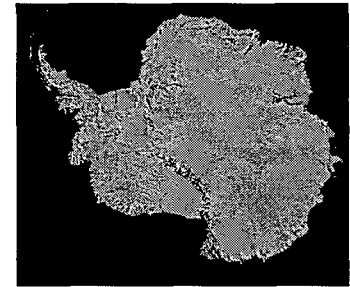


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Europa

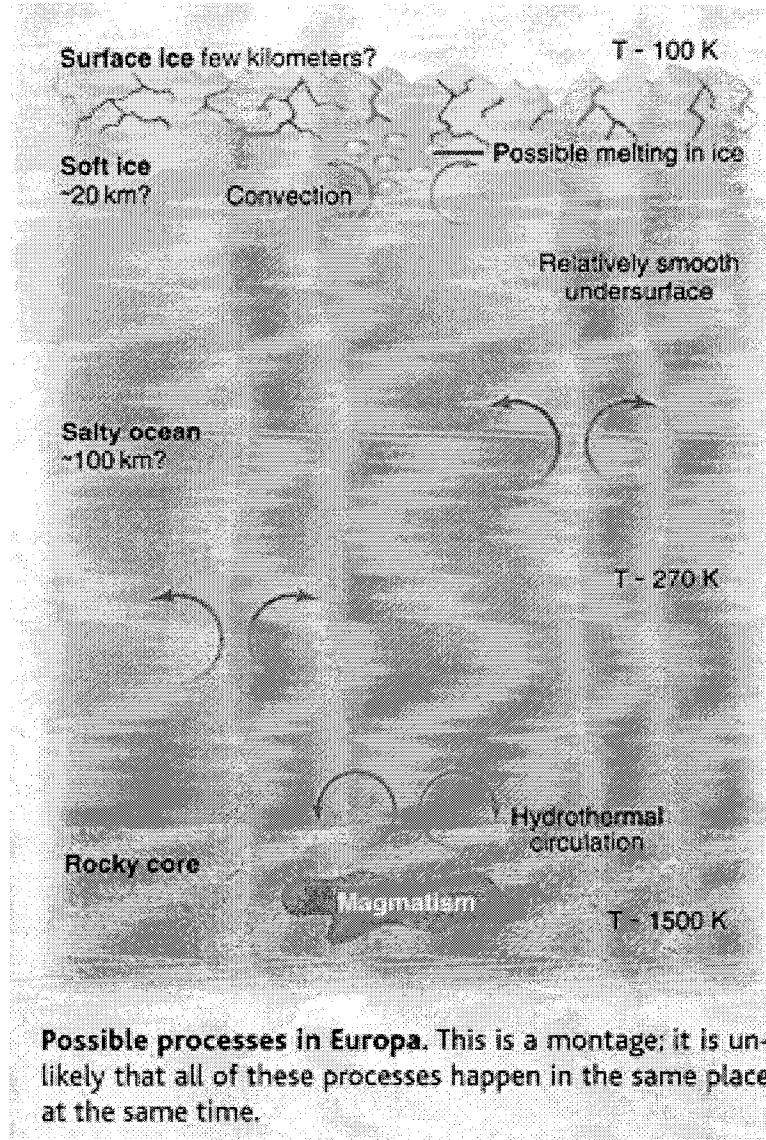
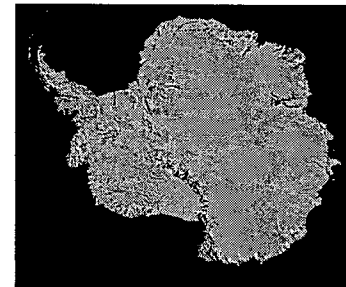


F Carsey, 2001

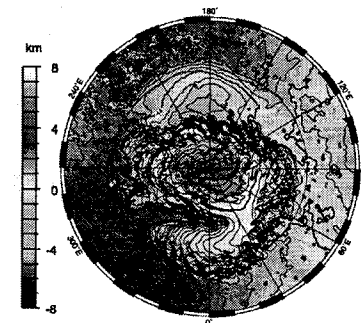
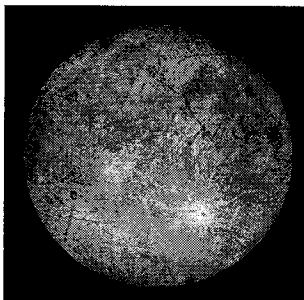




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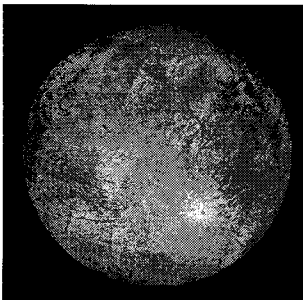
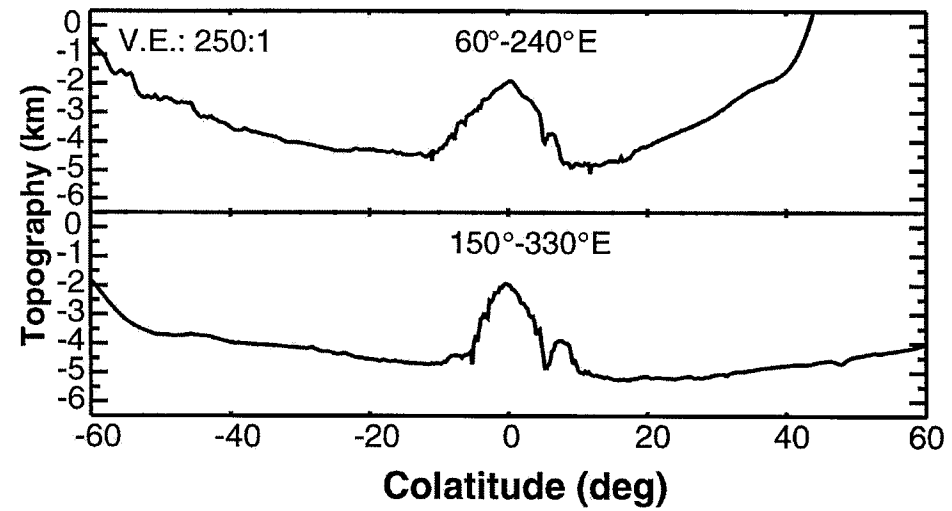
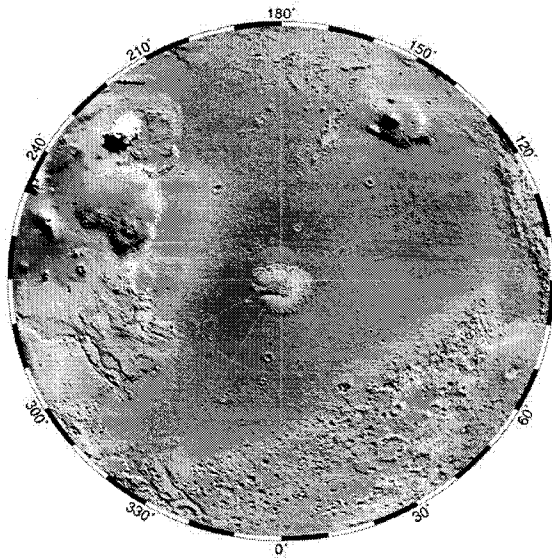
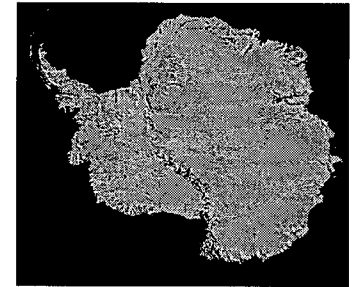
A Concept of the
Europa Ice and Ocean
Due to David
Stevenson of Caltech,
Science, 2000



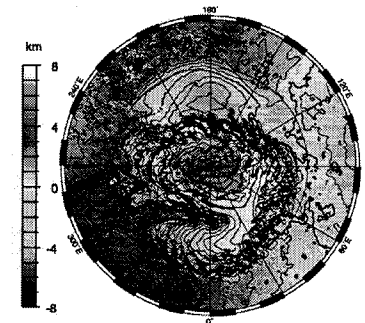


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Mars North Pole



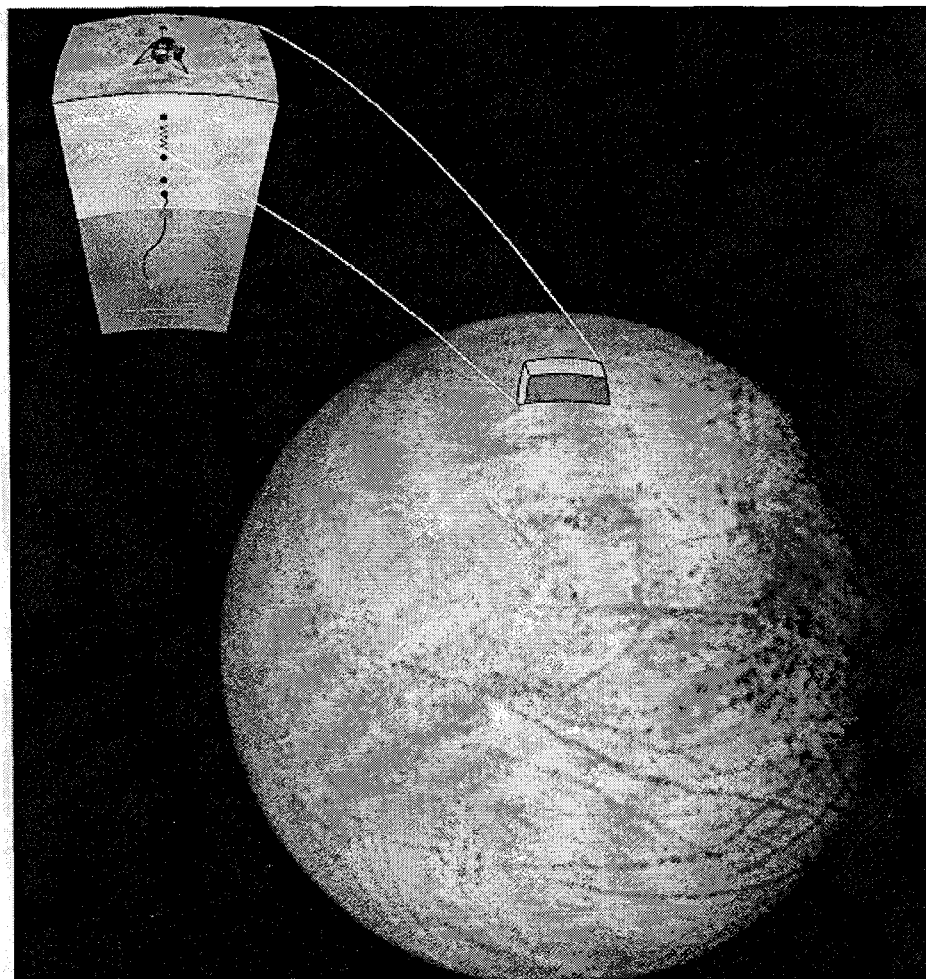
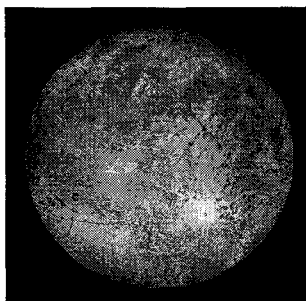
F Carsey, 2001



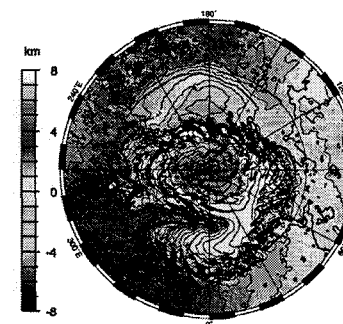
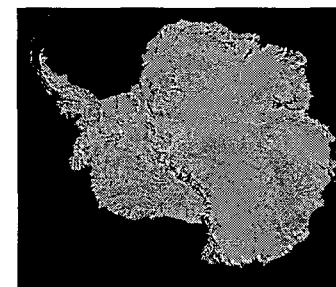


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Cover and Article
in
*Marine
technology
Society
Journal*, 33, 23-
28, 200 0



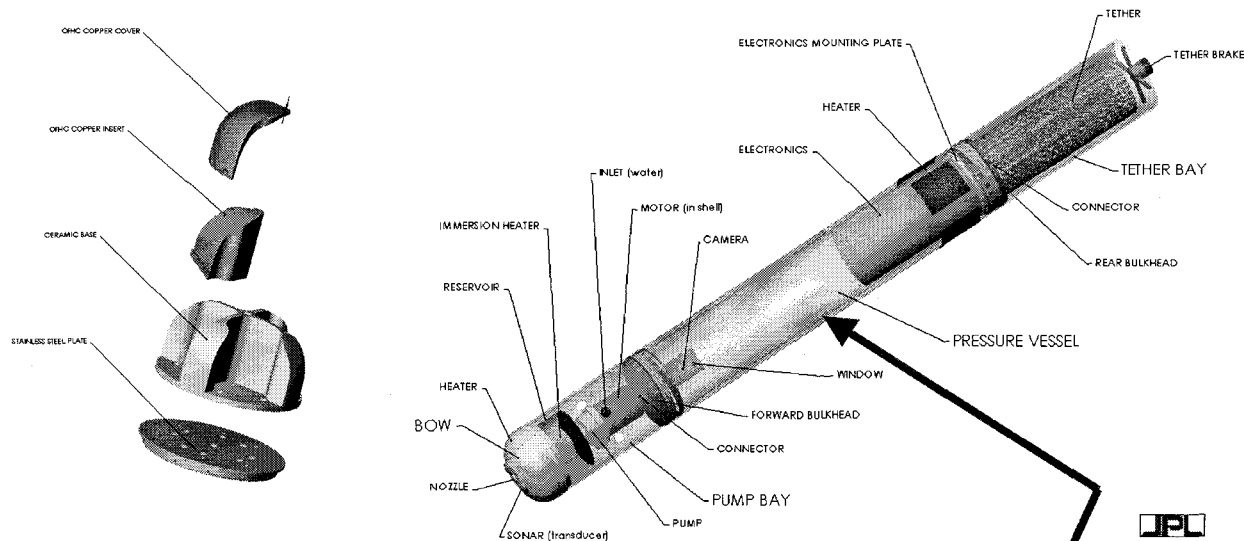
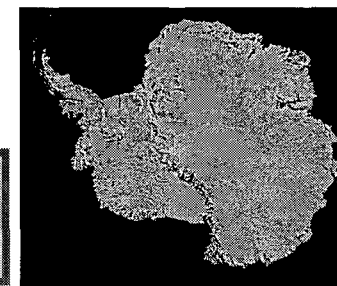
F Carsey, 2001



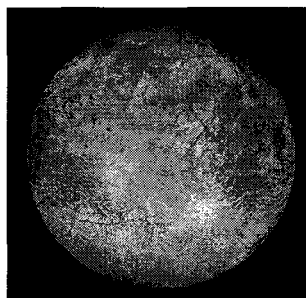


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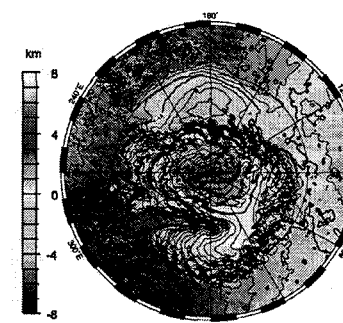
**SUBGLACIAL ACCESS: NASA-JPL "CRYOBOT" VER. 1 --
BEFORE NASA THESE WERE CALLED PHILBERTH PROBES**



Note Pressure Vessel



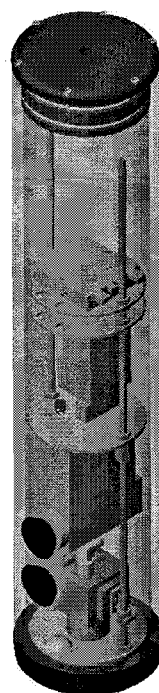
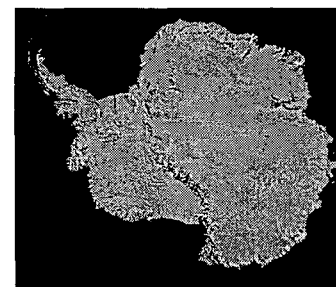
F Carsey, 2001



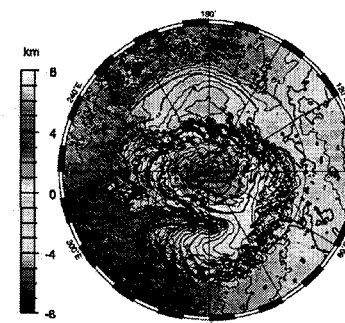
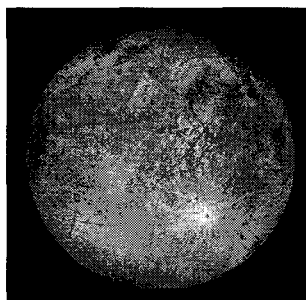


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PRESSURE VESSEL TESTBED:
Ice Camera Probe
Caltech-JPL West Antarctic Basal Ice Study



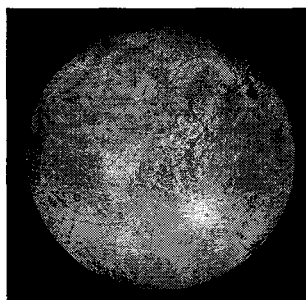
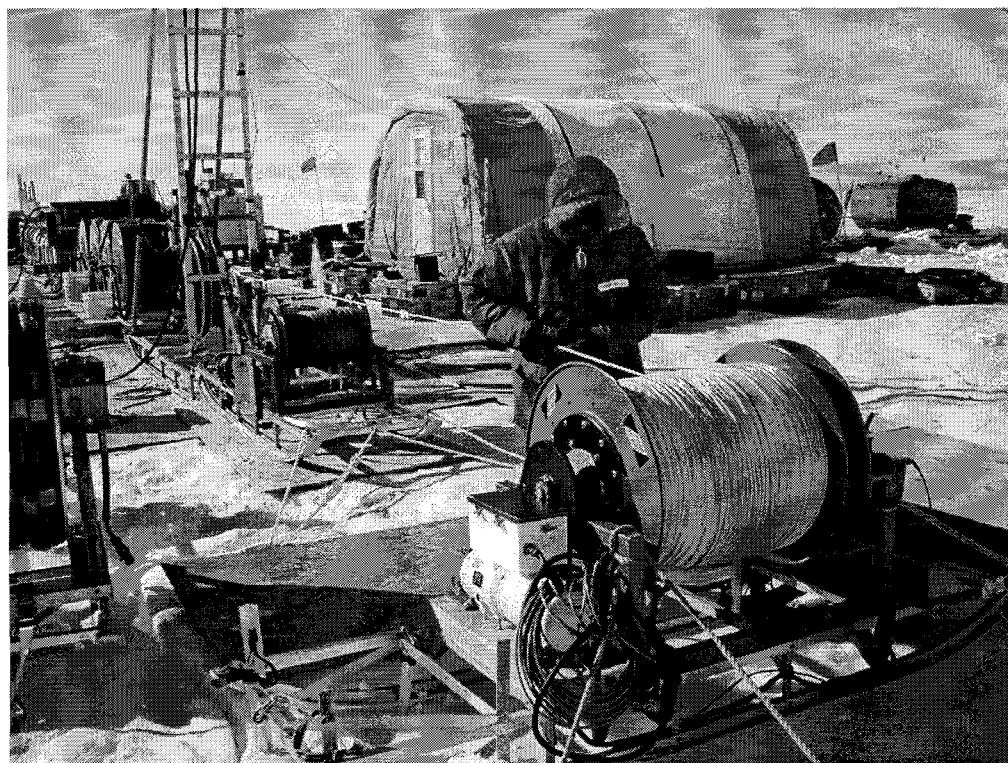
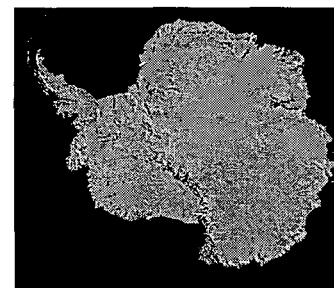
F Carsey, 2001



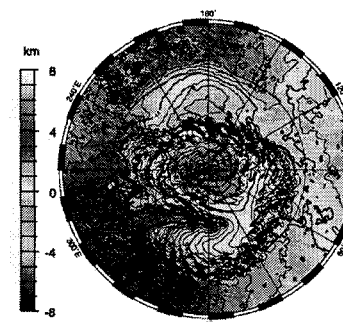


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BOREHOLE CAMERA DEPLOYMENT

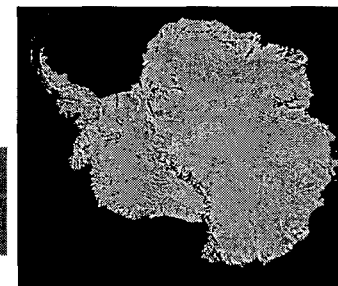


F Carsey, 2001



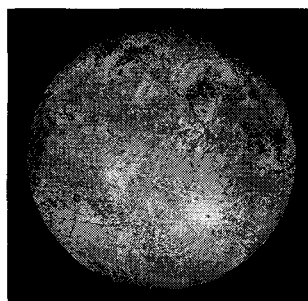


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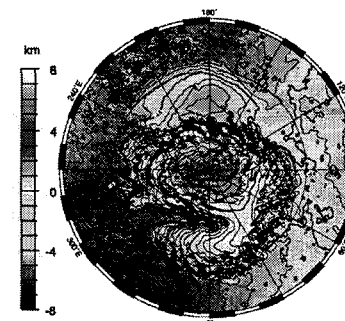


KEY PERFORMANCE METRICS

FY01	SOA	Goal
Hardware Technology		
Nose heaters	5W/cm2	8W/cm2
Pump heaters	40W/cm	60W/cm
Tether	0.9cm DIA	0.3cm DIA
Tether Deploy	spool	spoolless
Electronics Package	7000cm3	3500cm3
High voltage	120VDC	400VDC
Icy Sample	clear	mixed
Instrument package	0	4
Performance Technology		
Temperature	-25C	-70C
Thermal Efficiency	75%	85%
Descent Performance	0.4m/hr	1.2m/hr
Ice/sediment mobility	10micron; 5%	750micron; 10%
Sensor control	open loop	closed loop
FY02	SOA	Goal
Hardware Technology		
bio-signature instrument	0	1
acoustic driver package	4000 cm3	1000 cm3
Performance Technology		
steering	verticle	5 deg off axis
obstacle avoidance	none	10 meters
Descent depth	5m	300m



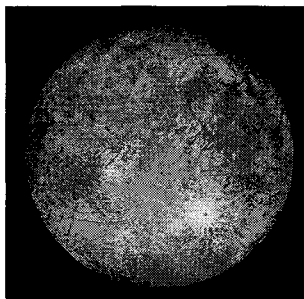
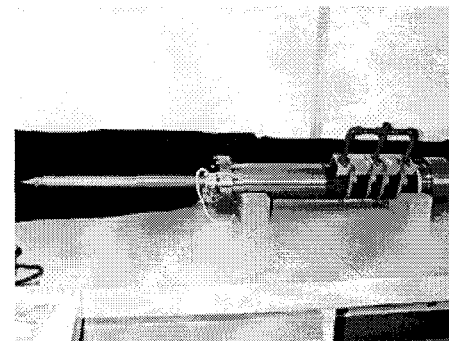
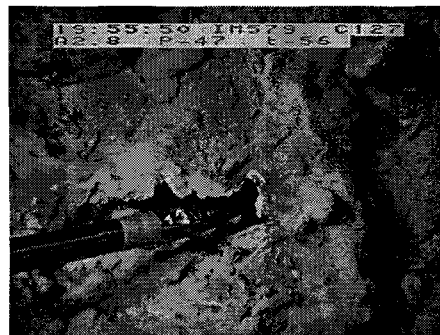
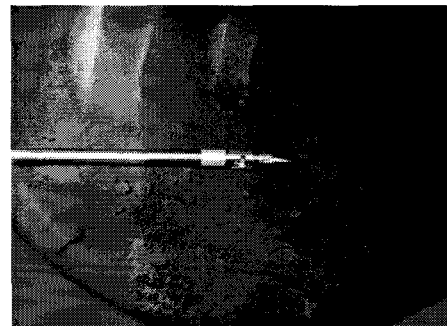
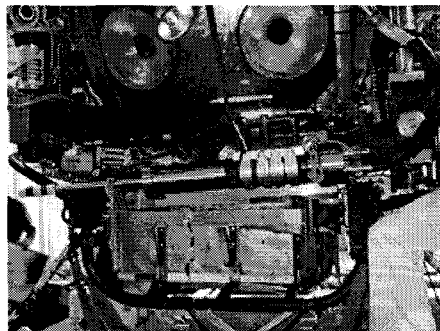
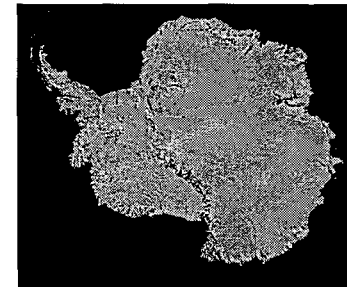
F Carsey, 2001



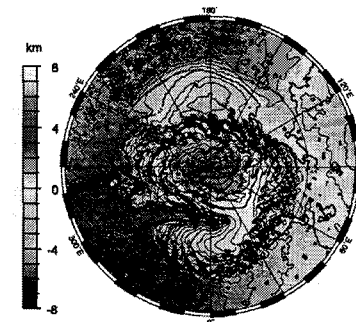


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HIGH PRESSURE INSTRUMENTATION: Hydrothermal Vent (Deep Water) Probe



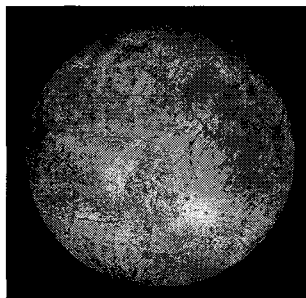
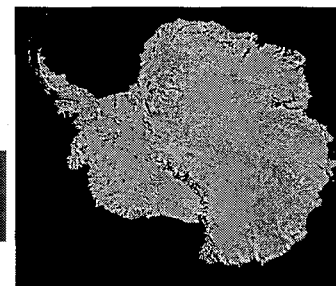
F Carsey, 2001



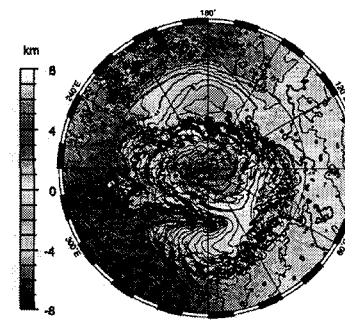


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ANTARCTIC BOREHOLE PHOTOGRAPHY: DEBRIS LAYERS



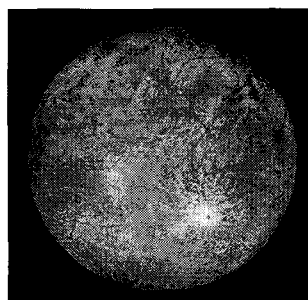
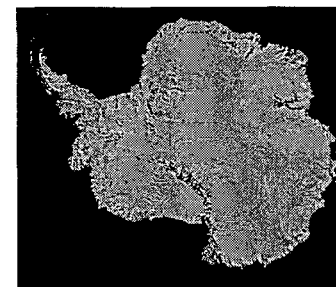
F Carsey, 2001





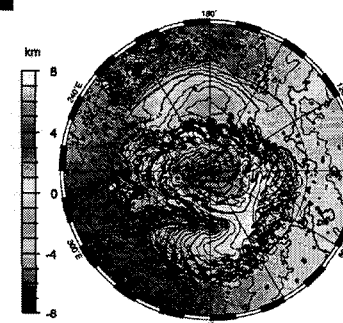
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ISOLATED CLASTS



Up in Figure is Down in Ice; Scale is About 3X5 cm

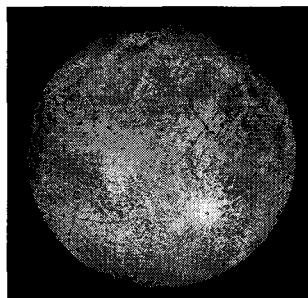
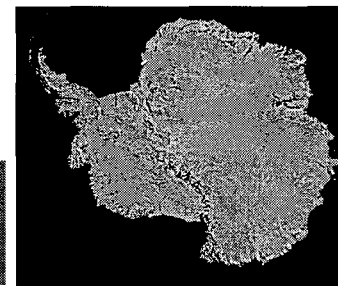
F Carsey, 2001



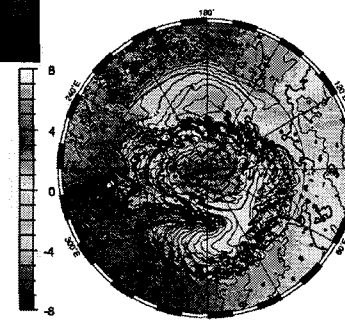


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ROOF OF SUBGLACIAL “LAKE” UNDER ICE STREAM C



F Carsey, 2001

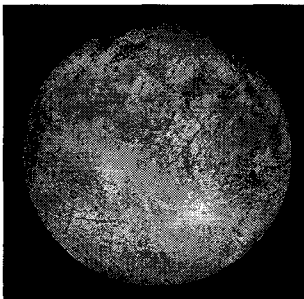




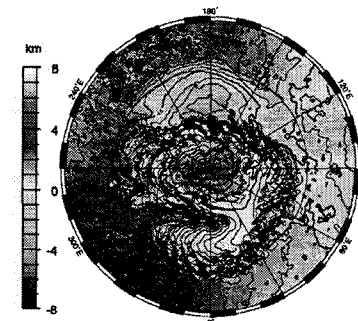
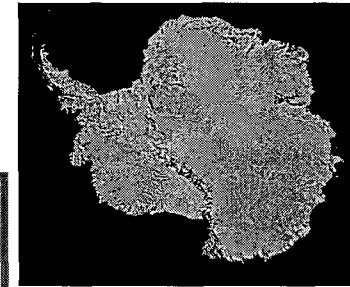
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IN SUMMARY: ICE IN-SITU EXPLORATION TECHNOLOGY: A COMPLEX TASK BUT MOVING FORWARD

- **New Results on Earth and Planetary Ice Call For Deep Subsurface In-Situ Exploration**
- First Results of Ice Borehole Probe From Antarctica Illustrate Utility of In-Situ Methods
- **Recalling In-Situ Data Acquisition Strategy--**
Where on planet/Where at site/What sample/What in sample?
- **We Are Making Headway:**
Laboratory Facilities for Testing New Ideas
Robotic Access to the Deep Subsurface
Micro-Instrumentation for In-Situ Science
- We Have Found It Necessary to Involve Many Funding Sources: Nothing New In That



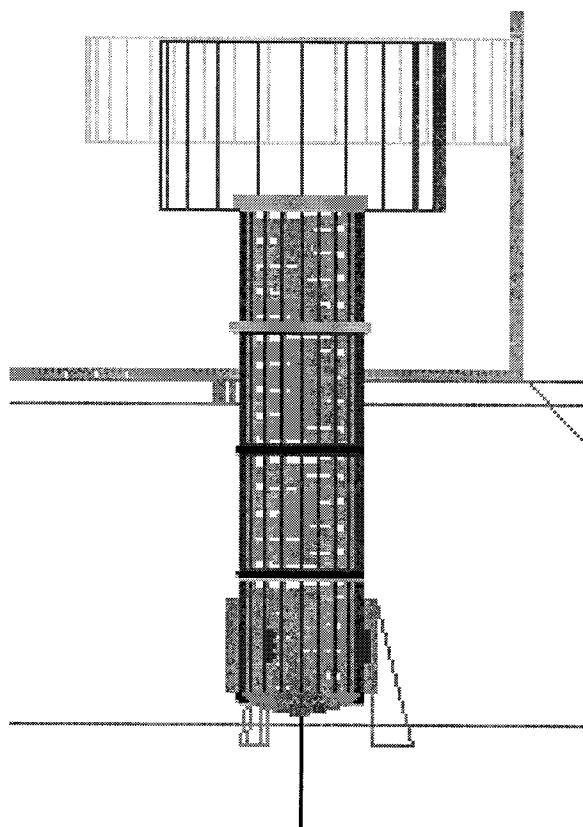
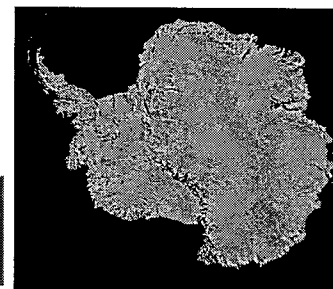
F Carsey, 2001



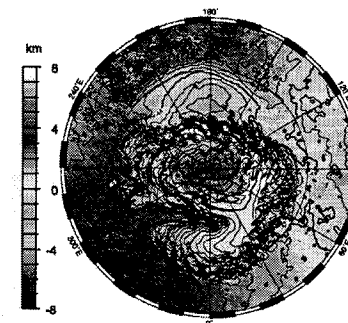
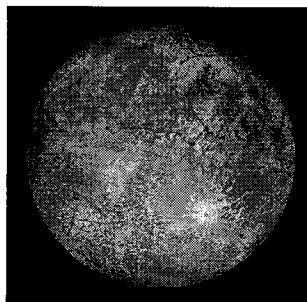


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ICE WELL UNDER CONSTRUCTION



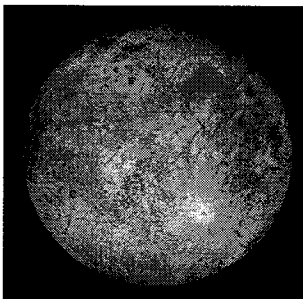
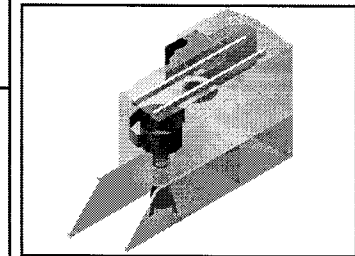
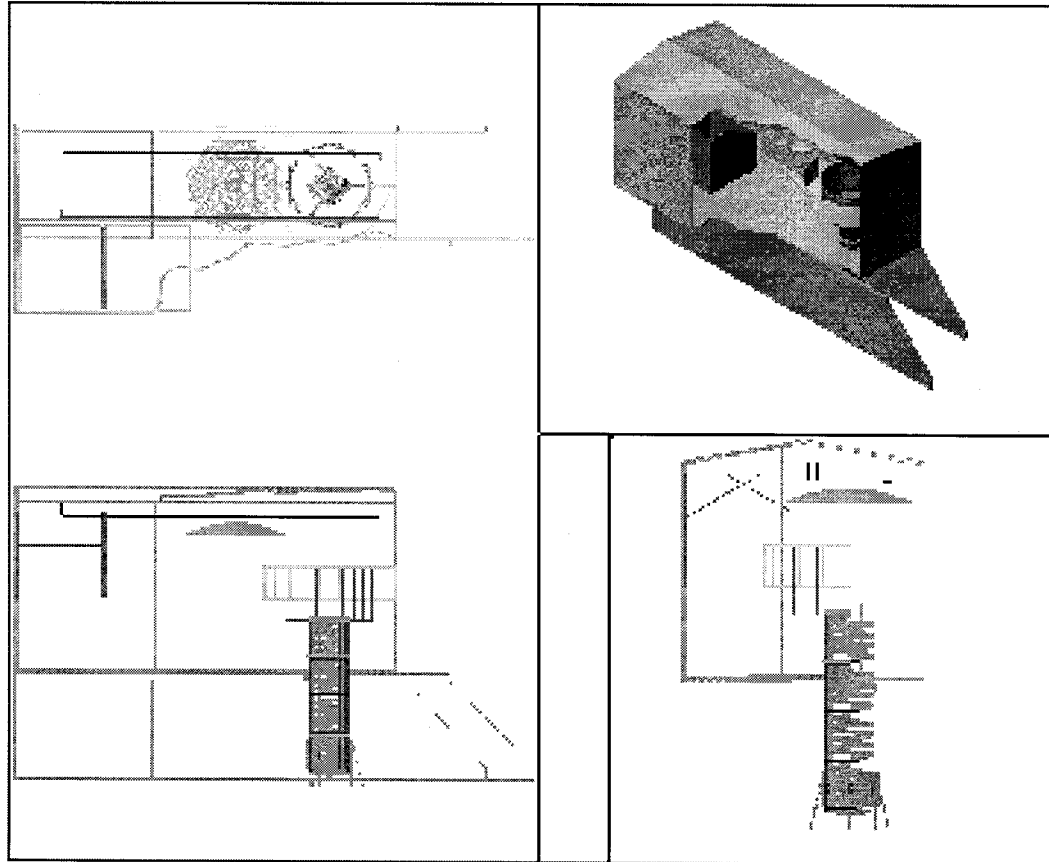
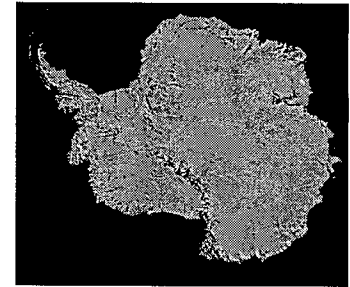
F Carsey, 2001





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CRYOLAB UNDER DEVELOPMENT



F Carsey, 2001

